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NSW DEPARTMENT OF  
PRIMARY INDUSTRIES

## Maintaining groundcover to reduce erosion and sustain production

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### INTRODUCTION

Managing pastures to maintain adequate levels of groundcover is the most effective way to minimise run-off and erosion. By reducing run-off, more water is made available for plant growth. By reducing erosion, soil, nutrients and organic matter are retained in place and siltation problems are minimised. In addition, groundcover is important for soil health and assists in weed control.

**Groundcover** is defined as any material on or near the soil surface that protects the soil against the erosive action of raindrops and overland flow. **Per cent groundcover** is the converse of per cent bare ground. Plant material, either alive or dead, is the most common and most important form of groundcover. Other materials such as loose surface stones, dung and snow can also provide an effective groundcover.

### IMPORTANCE OF GROUNDCOVER

Falling raindrops possess energy that is dissipated on striking bare soil by breaking down soil structure and detaching and transporting soil particles. The detached particles typically form a surface seal that reduces soil infiltration rates and increases run-off. Plant cover protects the soil by intercepting raindrops, impeding run-off flow and dissipating the associated energy. Without adequate groundcover up to 85% of the rainfall from

individual storms can run off into creeks and streams rather than soak into the soil and be available for plant growth. Maximising the availability of rainwater is critical in Australia where water is often the most limiting factor to agricultural production.

Where the soil is left unprotected, up to 100 t/ha of valuable topsoil can be lost in a year (1 mm depth of soil over one hectare weighs around 10 t). Eroded soil cannot be readily replaced and will have a major impact on the sustainability and profitability of your property. Eroded soil may also fill dams, creeks and rivers and contribute to flooding. Sediment also contains large amounts of valuable plant nutrients that can adversely affect water quality and encourage algal blooms.

Research conducted at Scone in the Upper Hunter Valley by the Department of Infrastructure, Planning and Natural Resources (DIPNR) has shown that at least 70% groundcover is required to prevent excessive run-off and erosion. This research was conducted on a red clay soil with a gentle slope of 10 per cent. Average annual rainfall was 625 mm. The results of this research are shown in Figure 1.

The minimum percentage amount of groundcover required to prevent excessive run-off and erosion could be expected to vary depending upon rainfall amount, intensity and seasonality, soil moisture, slope gradient and length and soil characteristics. It is therefore

necessary to consider these variables when deciding on a minimum amount of groundcover for different situations in the same area or different parts of New South Wales.

In addition, research by the NSW Department of Primary Industries (NSW DPI) has shown the benefits of adequate groundcover on soil health, and hence productivity, and in providing a natural barrier against weed invasion. Tactical grazing and fertiliser application can play a crucial role in maintaining adequate groundcover, in improving soil health and in achieving sustainable production.

This Agfact provides estimates of the amount of groundcover needed to reduce surface run-off and soil erosion on a range of soil types and slope gradients in selected areas of the State.

## ROLE OF GROUNDCOVER

To understand the role of groundcover in controlling run-off and soil loss from pastureland it is important to recognise that there are two important components of groundcover: canopy and contact cover.

**Canopy** cover is standing plant herbage greater than 5 cm in height.

**Contact** cover is herbage that is in contact with the soil and includes prostrate stems and leaves, litter and basal areas of plants. Attached plant material is more effective than unattached material (litter) for run-off and erosion control as it is not subject to being carried away in run-off.

### Raindrop interception

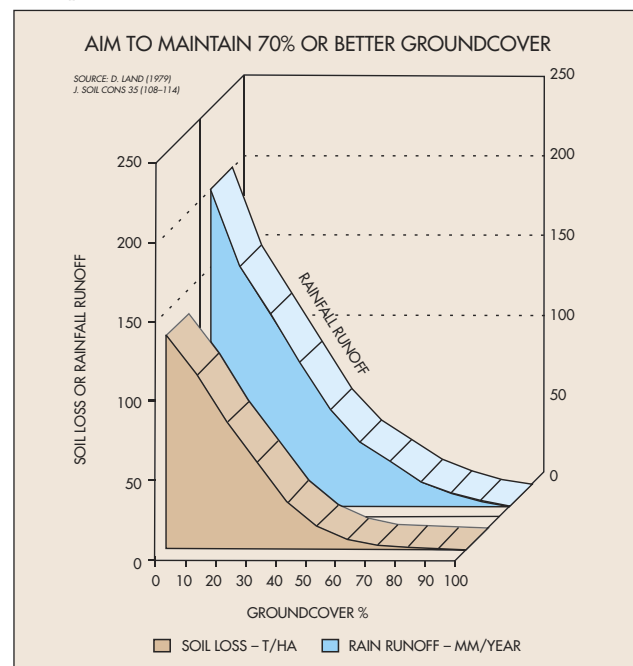
The first role of groundcover is to intercept raindrops and stop them impacting on the soil surface and destroying soil structure. If soil structure is maintained, soil infiltration rates will also be maintained and most of the rainwater will soak into the soil. Canopy and contact cover are both important in protecting the soil against raindrop impact. However, once run-off starts, the amount of contact cover becomes critical.

### Run-off

The second role of cover is to impede and slow run-off water to give it more time to infiltrate and to allow deposition of sediment. Contact cover is critically important in controlling surface run-off and promoting deposition of sediment, and preferably this cover should be living plants.

**Figure 1. Effect of groundcover on the amount of soil loss and water run-off from pastures.**

(Adapted from Lang 1979)



Litter is effective only if it is not carried away in the run-off.

Plants with an erect habit, such as lucerne, may not effectively impede surface run-off and so may provide little protection to the soil against erosion. A stand of lucerne approaching flowering may have a canopy cover of, say, 75% but, because lucerne has little contact cover and litter is usually sparse, erosion can still occur. It is therefore important that contact cover is greater in pasture on sloping country than on flatter country.

### Drainage lines

Drainage lines may conduct large volumes of run-off water with considerable depth and velocity. Consequently, there is little opportunity for infiltration of water and deposition of sediment and any bare ground is likely to be the focus for erosion and formation of gullies.

The target groundcover in drainage lines should therefore be 100% contact cover.

Drainage lines should be fenced and maintained for the safe disposal of run-off water. Slashing or grazing should be used to maintain pasture vigour and minimise build-up of dry matter that may obstruct surface flow.

## ADEQUATE GROUNDCOVER

The amount of groundcover is deemed to be adequate where run-off is minimal and soil erosion does not exceed the rate of soil formation. As can be seen in the example from Scone (Figure 1), run-off and erosion are both slight where groundcover exceeds about 70%, but they both increase rapidly as groundcover is reduced below this value.

This response to groundcover is attributed to a geometric pattern of bare ground and plants that usually occurs in pastures. Where groundcover is high (>80%), any bare ground tends to occur as relatively small isolated 'islands' in a 'sea' of plants. Run-off generated on bare ground is quickly absorbed in the extensive barrier of plants downslope and any sediment in the run-off water is quickly deposited.

As groundcover is reduced, the patches of bare ground begin to interconnect, which allows run-off water to flow more freely and so increase its capacity to erode the soil. Where groundcover is low, the geometric pattern is reversed with plants tending to occur as isolated 'islands' in a 'sea' of bare ground. Run-off water can flow freely, is rarely impeded or absorbed, its erosive capacity is high and there is little opportunity for deposition of sediment.

Research by DIPNR has shown that 90% of soil loss occurs from only 10% of storms. As these storms tend to have a higher intensity and amount of rainfall, aim to keep pasture cover at or above the estimated minimum cover for your soil type and slope during high-risk periods. For example, for inland NSW the high-risk period extends from October to March when the frequency of high intensity storms is greatest.

## MANIPULATING GROUNDCOVER

**Plant type** can have a significant effect on both run-off and erosion. Where the risk of erosion is high, selecting appropriate pasture species can reduce that risk by reducing raindrop impact and impeding water flow.

Select pasture species that are well adapted to your climate, soil and grazing regime so that they will persist. If species do not persist they may be replaced by less desirable species, and this could result in larger areas of bare ground at critical times of the year.

Perennial pasture species are preferred to annuals because of their greater potential to provide year-round cover and production of herbage. Grasses, which have fibrous root systems, are preferable to species with tap roots as they are more effective at increasing



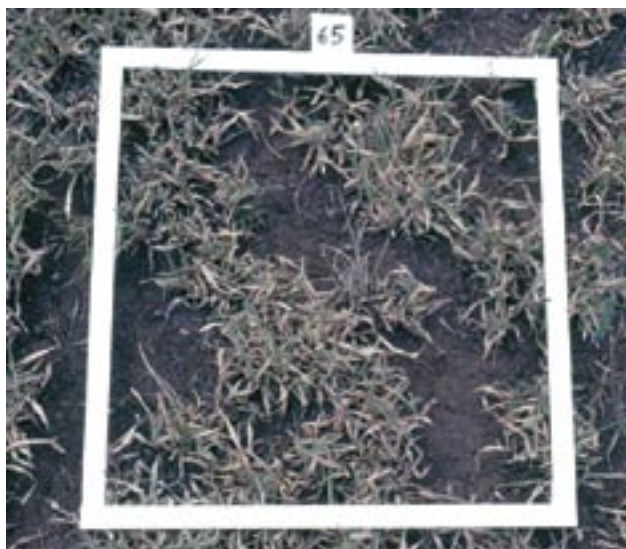
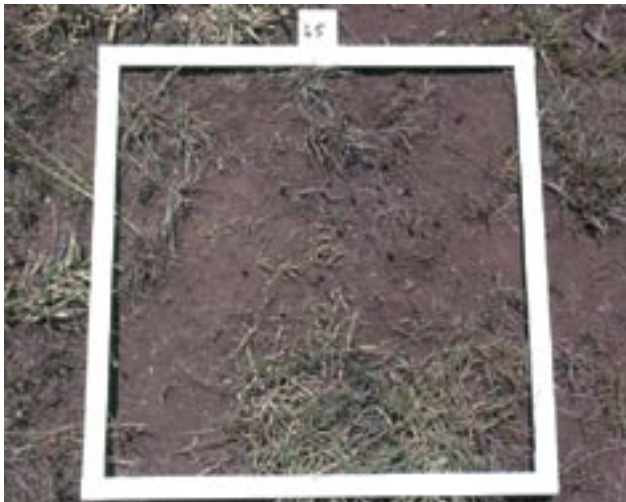
**A comparison of fertiliser treatments on pasture near Tamworth on a degraded low fertility red brown earth in summer. The groundcover of the fertilised plot (10 kg/ha of phosphorus and 25 kg/ha of sulfur) was 88% while the cover on the unfertilised plot was 48%. Data: G Crocker, NSW DPI, Tamworth.**

soil organic matter, improving soil structure and maintaining infiltration rates. Species with above-ground runners or stolons, such as kikuyu and couch, offer other advantages such as their ability to spread vegetatively and provide good contact cover. This is especially important in drainage lines.

When selecting pasture species, the above characteristics need to be considered along with the characteristics necessary for the needs of the enterprise, in terms of feed quality and quantity. In addition, good pasture management, including the use of appropriate legumes and fertilisers to correct nutrient deficiencies and regular resting, can improve groundcover.

### ESTIMATING GROUNDCOVER

There are many different ways of assessing groundcover in pastures, such as visual,



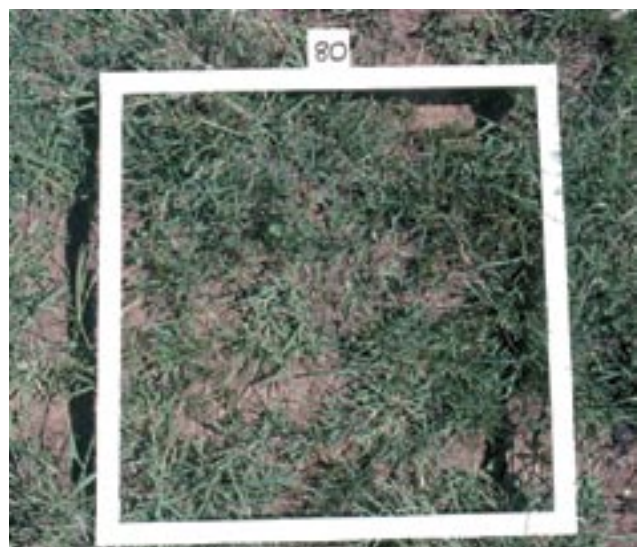
photographic and point, linear and area quadrats. Different methods have different time requirements, involve different types of equipment, and have different levels of reliability. Most require some form of calibration to ensure a reasonable level of accuracy. The method selected will often depend on needs, type of pasture and convenience.

When assessing groundcover a representative section of the paddock should be selected. Groundcover levels will vary across a paddock, between paddocks and over time, because of differences in pasture type, plant growth, grazing pressure, grazing habits of stock, paddock aspect and soil type, fertility and moisture. Atypical areas and different land units may have to be fenced out and assessed separately to facilitate management according to their different characteristics.

A simple method which gives an approximate estimate of groundcover involves standing in a representative part of the pasture with your feet half a metre apart.

Visualise a square  $0.5 \times 0.5$  m (18"  $\times$  18") in front of your feet and look vertically into the pasture to estimate the percentage of the area that is covered by plant material and litter. Do this, say, ten times in the paddock and average out the results.

**Hint:** Imagine the square is divided into thirds (some observers prefer quarters), then mentally move all the bare areas into one section. If the bare areas fill less than one section, then cover



**Typically, in grass-based pastures, once groundcover falls below about 70% patches of bare ground join up and both run-off and water erosion increase dramatically. However, the minimum amount of groundcover required to control run-off and erosion can be affected by slope, rainfall and soil type.**

**Photos: top left: 45% groundcover, bottom left: 65% groundcover and right: 80% groundcover.**

exceeds 66% (or 75% if using quarters). That is, groundcover is greater than approximately 70%.

Note that this method, although quick and simple, can be less accurate than other methods. Observers using this method tend to underestimate groundcover, particularly in the mid-range, compared with more reliable methods (Murphy and Lodge 2002). Accuracy can be improved by using photo guides of reference quadrats with known amounts of groundcover.

Groundcover estimates are complementary with other pasture assessments associated with management systems such as ProGraze and Holistic Resource Management. Readers interested in other methods of estimating groundcover are referred to texts such as t'Mannetje and Jones (2000).

## **MINIMUM GROUNDCOVER ESTIMATES**

Minimum groundcover values that protect against excessive surface run-off and erosion (Tables 1–4) have been defined using SOILOSS, a decision support system developed by DIPNR. These values take into account average annual rainfall, rainfall intensity and seasonality, slope gradient and soil type and health. Locations given in the tables identify the Bureau of Meteorology stations from which rainfall data were used. Users should select the table that most closely aligns to the climate and soil type of their location. Maintaining groundcover levels above these guidelines should reduce run-off

and soil loss to acceptable levels (that is, less than 2 t/ha of soil per annum on average on moderate slopes and less than 1 t/ha on steep slopes).

The estimates were generated for areas of NSW with greater than 400 mm average annual rainfall in the south of the State and greater than 500 mm in the north, but less than 2000 mm overall. The SOILOSS model works better within these limitations and also for moderately sloping country as opposed to flat or steep country.

In addition, although SOILOSS does not consider wind erosion, maintaining these minimum cover values should effectively control wind erosion, which is a problem mainly in western NSW but can also occur further east during drought.

Guidelines for western NSW rangelands are available from the NSW DPI Rangeland Management Unit at Trangie, or offices of DIPNR in the Far West or the western Murray/Murrumbidgee Regions.

In Tables 1 to 4, on the next pages, 'flat' refers to country with less than 2% slope (1°), 'gentle' to slopes of 2–10% (1°–5°), 'moderate' to slopes of 10–20% (5°–11°) and 'steep' to slopes of >20% (>11°). The slope gradient descriptions are not suited to all regions and are given for guidance only.

Groundcover values given in parentheses for the Northern, Central and Southern Slopes and Plains apply to the western margin of these regions where low annual rainfall may limit the ability of the country to consistently sustain higher values under profitable grazing systems. In these regions, cryptogams (that is, lichens, liverworts, mosses and hornworts) and, perhaps, vegetation patchiness have key roles in stabilising soil surfaces against both water and wind erosion. Grazing strategies should recognise these issues.

## **FURTHER INFORMATION**

For further information contact your local DIPNR Natural Resources Officer or DPI District Agronomist.

### **ALWAYS READ THE LABEL**

Users of agricultural or veterinary chemical products must always read the label and any Permit, before using the product, and strictly comply with the directions on the label and the conditions of any Permit. Users are not absolved from compliance with the directions on the label or the conditions of the Permit by reason of any statement made or omitted to be made in this publication.

### **DISCLAIMER**

The information contained in this publication is based on knowledge and understanding at the time of writing in January 2005. However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up-to-date and to check the currency of the information with the appropriate officer of NSW Department of Primary Industries or the user's independent adviser.

## FURTHER READING/REFERENCES

Lang, D 1979, diagram on soil loss, adapted in R Watson, W McDonald & B Freebairn 1994, *Saleable stock from stable pastures*, 2nd edn, NSW Agriculture, Orange.

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## ACKNOWLEDGMENTS

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**TABLES 1–4: Estimates of minimum amounts of groundcover (%) required to reduce excessive run-off and erosion and sustain productivity for a range of slope gradients (as defined) and soil erodibility classes.**

**Table 1. Coastal regions**

| Grafton, Maitland, Bega |  | Paddock slope |        |          |       |
|-------------------------|--|---------------|--------|----------|-------|
| Erodibility             | Typical soil types   | Flat          | Gentle | Moderate | Steep |
| Low                     | • deep sands   | 60            | 80     | 90       | 100   |
| Low–moderate            | • sandy loams, light clays<br>• uniform clays, kraznozems and euchrozems (ferrosols)                                     | 60            | 85     | 95       | 100   |
| Moderate–high           | • loams<br>• self-mulching black earths (vertosols)  | 65            | 90     | 100      | 100   |
| High                    | • silts, fine sandy loams<br>• red-brown earths (chromosols), red and yellow earths (kandosols)<br>• solodics (sodosols) | 70            | 90     | 100      | 100   |
| Low–high                | • drainage lines (all soil types)  | 100           | 100    | 100      | 100   |

**Table 2. Tableland regions**

| Armidale, Orange |  | Paddock slope |        |          |       |
|------------------|--|---------------|--------|----------|-------|
| Erodibility      | Typical soil types   | Flat          | Gentle | Moderate | Steep |
| Low              | • deep sands   | 60            | 65     | 80       | 90    |
| Low–moderate     | • sandy loams, light clays<br>• uniform clays, kraznozems and euchrozems (ferrosols)                                     | 60            | 70     | 85       | 95    |
| Moderate–high    | • loams<br>• self-mulching black earths (vertosols)  | 60            | 75     | 85       | 100   |
| High             | • silts, fine sandy loams<br>• red-brown earths (chromosols), red and yellow earths (kandosols)<br>• solodics (sodosols) | 60            | 80     | 90       | 100   |
| Low–high         | • drainage lines (all soil types)  | 100           | 100    | 100      | 100   |

**Table 3. Northern Slopes and Plains**

| <b>Narrabri, Tamworth, Trangie</b> |  | <b>Paddock slope</b> |               |                 |              |
|------------------------------------|--|----------------------|---------------|-----------------|--------------|
| <b>Erodibility</b>                 | <b>Typical soil types</b>  | <b>Flat</b>          | <b>Gentle</b> | <b>Moderate</b> | <b>Steep</b> |
| Low                                | • deep sands   | 60 (40)              | 60            | 75              | 90           |
| Low–moderate                       | • sandy loams, light clays<br>• uniform clays, kraznozems and euchrozems (ferrosols)                                     | 60 (40)              | 65            | 80              | 95           |
| Moderate–high                      | • loams<br>• self-mulching black earths (vertosols)  | 60 (40)              | 70            | 85              | 95           |
| High                               | • silts, fine sandy loams<br>• red-brown earths (chromosols), red and yellow earths (kandosols)<br>• solodics (sodosols) | 60 (40)              | 75            | 90              | 100          |
| Low–high                           | • drainage lines (all soil types)  | 100                  | 100           | 100             | 100          |

**Table 4. Southern and Central Slopes and Plains**

| <b>Wagga Wagga, Deniliquin</b> |  | <b>Paddock slope</b> |               |                 |              |
|--------------------------------|--|----------------------|---------------|-----------------|--------------|
| <b>Erodibility</b>             | <b>Typical soil types</b>  | <b>Flat</b>          | <b>Gentle</b> | <b>Moderate</b> | <b>Steep</b> |
| Low                            | • deep sands   | 60 (40)              | 60            | 65              | 85           |
| Low–moderate                   | • sandy loams, light clays<br>• uniform clays, kraznozems and euchrozems (ferrosols)                                     | 60 (40)              | 60            | 70              | 90           |
| Moderate–high                  | • loams<br>• self-mulching black earths (vertosols)  | 60 (40)              | 60            | 75              | 90           |
| High                           | • silts, fine sandy loams<br>• red-brown earths (chromosols), red and yellow earths (kandosols)<br>• solodics (sodosols) | 60 (40)              | 65            | 80              | 95           |
| Low–high                       | • drainage lines (all soil types)  | 100                  | 100           | 100             | 100          |



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